HWG | HARRIS, WILTSHIRE & GRANNIS LLP

November 12, 2019

<u>Ex Parte</u>

Marlene Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Re: *Unlicensed Use of the 6 GHz Band*, ET Docket No. 18-295; *Expanding Flexible Use in Mid-Band Spectrum between 3.7 and 24 GHz*, GN Docket No. 17-183

Dear Ms. Dortch:

On November 7, 2019, representatives of Apple Inc., Broadcom Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, Intel Corporation, Marvell Semiconductor, Inc., and Qualcomm Incorporated met with the Office of Engineering and Technology. A complete list of attendees in that meeting is attached. Separately, Thomas Navin and Alan Norman of Facebook, Inc. met with Commissioner Carr and Will Adams, Legal Advisor to Commissioner Carr.

In those meetings, the participants discussed the importance of authorizing a class of very low power ("VLP") unlicensed devices in the 6 GHz band. Because VLP devices would be restricted to a mere 25 mW (14 dBm) EIRP, this device class will not be suitable for general purpose Wi-Fi access points or other similar applications. This extremely tight power restriction will likely limit high bandwidth communications to a range of approximately one meter. However, while VLP will not support traditional access points, this device class will be critical for supporting indoor and outdoor portable use cases such as wearable peripherals including AR/VR and other "personal-area-network" applications. Without usable VLP rules, it is unlikely that such devices will be practical in the near term due to the lack of the wide channels needed for low latency applications for outdoor use. We discussed the attached analysis which demonstrates that, because of their very low power levels, combined with body loss and other real-world considerations such as the use of transmit power control, VLP devices do not pose a harmful interference risk, even in the corner cases described in the attached presentation.

We also discussed low-power indoor devices, which will be the key to serving indoor environments such as homes and enterprises. These devices likewise pose no threat of harmful interference due to a combination of strict power limits—1 W (30 dBm) EIRP—and building entry loss. We also reiterated our proposal that FCC rules state that LPI access points:

1. Must use integrated antennas. This would prohibit the marketing of any low-power-indoor device with antenna connectors or that is otherwise designed in a way that would permit end users to replace or modify the device's antennas.

2. Must not use any type of weatherproofed enclosure.

3. Must cease functioning when the device is not connected to mains power. This would prohibit the use of battery powered 6 GHz LPI radios.[1]

4. Must comply with a clear labeling requirement to ensure that any consumer who illegally modifies or misuses a low-power-indoor device would be in knowing and willful violation of Federal Communications Commission regulations.

With this combination of technical rules and operational restrictions, both VLP and LPI devices—in addition to devices under the control of an Automated Frequency Coordination system—can operate in the 6 GHz band without a risk of harmful interference to incumbents.

Sincerely,

Paul Margie
Counsel to Apple Inc., Cisco Systems, Inc., Facebook, Inc., Google LLC, and Broadcom Inc.

[1] Some 6 GHz RLAN devices may require battery power for other features, which the Commission's rules should permit for low-power indoor devices.

MEETING PARTICIPANTS

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*Participated via telephone

VLP Coexistence Analysis

VLP Background

Very-low-power (VLP) devices are a critical indoor/outdoor device class for enabling 5G speeds to mobile peripherals.

Use cases: Immersive AR/VR; mobile peripherals; in-car connectivity. Power levels too low for use in Wi-Fi routers and other infrastructure.

Extremely low power levels: No higher than 14 dBm EIRP (25 mw).

Short range: Generally far less than three meters.

Battery powered: VLP devices will transmit infrequently and at the lowest power possible.

Antenna directivity: Peak gain will never be realized from all antennas in the exact same direction.

Example Use Case: **Mobile Peripherals**

Critical 6 GHz use cases such as immersive AR/VR connectivity and other advanced peripherals will be core VLP applications.

The connection between AR glasses and a smartphone, for example, would be VLP.

- LPI rules are inappropriate because they would prohibit outdoor operations for watches, earphones, glasses, and other mobile devices.
- AFC rules are unnecessary for extreme low powers and would increase costs beyond what the market would bear for peripheral devices.

These advances will not be practical without VLP rules that support investment.

The combination of extremely low radiated power, dynamic location, transmit power control, body loss, and antenna mismatch will prevent harmful interference.

Transmit Power Control + Body Loss Will Further Reduce Interference from VLP Mobile Peripherals

Because VLP devices will be battery powered, they will use transmit power control to reduce EIRP to the minimum needed to communicate between devices.

Body loss, which can be very significant for worn devices, will be a dominant factor attenuating VLP signals. *See On-Body Channel Measurement – IEEE Transactions on Antennas and Propagation, Vol. 60, No. 7, July 2012*

As a further optimization, VLP devices that use beamforming will ensure that what little energy is transmitted is directed between VLP devices, and not where it could cause harmful interference.

Analysis: **Mobile Peripherals at Ground Level**
Example 1 – Typical Scenario

In a case where a VLP device is at ground level, I/N is far below a level that could possibly cause harmful interference.

- Body loss in the 6 GHz band ranges from 4.5 to more than 60 dB.
- Assuming 4.5 dB body loss, at 1 meter transmit power control (TPC) is expected to reduce power by at least 14 dB because battery efficiency is paramount for wearables.
- If there is additional body loss, TPC will correspondingly increase the power to the minimum needed for the desired use case, up to 14 dBm.

Additional assumptions: 6 m FS antenna size; 43 m FS receiver height; 30 MHz FS bw.

RLAN Bandwidth	160 MHz
Maximum RLAN EIRP	14 dBm
Body Loss / Transmit Power Control	-18 dB
Effective RLAN EIRP	-4 dBm
Feeder/System Loss	-2 dB
Polarization Mismatch	-3 dB
Antenna Mismatch	-3 dB
FS-RLAN Distance (horiz.)	5000 m
FS Gain (@0.48 degrees)	38.2 dB
Prop. Loss (WII NLOS)	172.6 dB
TOTAL I/N	**-59.5 dB**

Analysis: **Mobile Peripherals at Ground Level**
Example 2 – Worst Case Distance

Even at the worst-case distance for the most common antenna configuration, predicted I/N is still far below a level that could possibly cause harmful interference: -17.2 dB.

This assumes both line of sight and a device at the exact worst-case distance from the FS receiver.

2.1 km is the distance at which, for the selected antenna, increased propagation loss begins to outpace increases in antenna gain as the device moves farther away.

At distances less than 2.1 km, an AP at ground level is off boresight and high FS antenna gain rejection dominates lower propagation loss.

Additional assumptions: 6 m FS antenna size; 43 m FS receiver height; 30 MHz FS bw.

RLAN Bandwidth	160 MHz
Maximum RLAN EIRP	14 dBm
Body Loss /Transmit Power Control	-18 dB
Effective RLAN EIRP	-4 dBm
Feeder/System Loss	-2 dB
Polarization Mismatch	-3 dB
Antenna Mismatch	-3 dB
FS-RLAN Distance (horiz.)	2145 m
FS Gain (@1.11 degrees)	35.3 dB
Prop. Loss (WII LOS)	127.5 dB
TOTAL I/N	**-17.2 dB**

Analysis: Mobile Peripherals above Ground Level

Example 3 – Hypothetical High-Rise Worst-Case Analysis

Even if we imagine a VLP device that is somehow (1) operating outside of the nearest high-rise building to the FS receiver, (2) high in the air in the main beam of a worst-case 6 m FS receiver, (3) unusually close to the FS receiver, (4) with no clutter, and (5) with totally unobstructed line of sight—it will not cause harmful interference.

Even in this unusual situation, the NYC lidar study illustrates that there is a limit to how close to the center of the main beam an RLAN device can be located, even in very dense urban environments.

Elevated outdoor use will still be affected by some degree of building entry or similar losses due to safety railings, glass, etc. 2 dB loss is a very conservative assumption in this unusual case.

Additional assumptions: 6 m FS antenna size; 43 m FS receiver height; 30 MHz FS bw.

(1) Building entry loss due to railing, tempered glass or other enclosure ranges from 2 to 30 dB

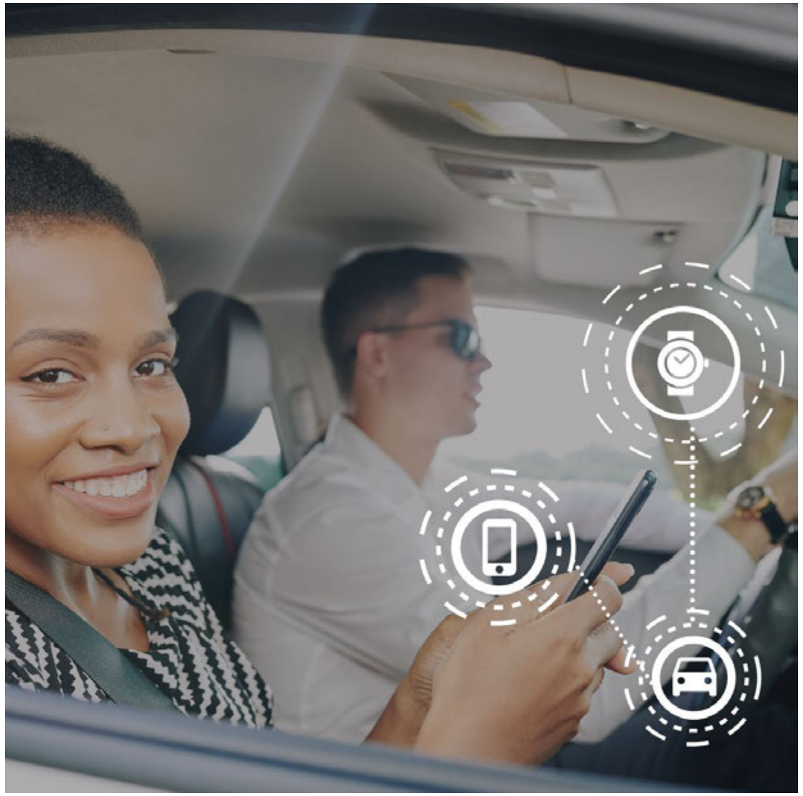
RLAN Bandwidth	160 MHz
Maximum RLAN EIRP	14 dBm
Body Loss / Transmit Power Control	-18 dB
Effective RLAN EIRP	-4 dBm
Feeder/System Loss	-2 dB
Building Entry Loss	-2 dB[1]
Polarization Mismatch	-3 dB
Antenna Mismatch	-3 dB
FS-RLAN Distance (horiz.)	2300 m
FS Gain (@0.95 degrees)	36.2 dBi
Prop. Loss (FSPL)	116.6 dB
TOTAL I/N	**-7.4 dB**

Example Use Case: In-Car Connectivity

Other important VLP uses will occur in vehicles where vehicle penetration loss further reduces the risk of harmful interference.

These applications include streaming from smartphones to infotainment systems (or vice versa), transmission of navigation data, and other applications.

As we demonstrated in our comments, 10 dB is a conservative average value for vehicle penetration loss.



Analysis: In-car connectivity near main beam

Risk of harmful interference also negligible for in-car VLP operation.

Vehicle penetration losses further reduce any likelihood of interference.

This case is also very conservative as it assumes line of sight, worst-case separation distance, no beamforming, and RLAN operations directly in front of an FS receiver at ground level.

As with earlier use cases, transmit power control will lead to the minimum power use necessary to achieve the desired use case.

Additional assumptions: 6 m FS antenna size; 43 m FS receiver height; 30 MHz FS bw.

RLAN Bandwidth	160 MHz
Maximum RLAN EIRP	14 dBm
Transmit Power Control/Body Loss/In-vehicle clutter	-18 dB
Effective RLAN EIRP	-4 dBm
Feeder/System Loss	-2 dB
Polarization Mismatch	-3 dB
Antenna Mismatch	-3 dB
Vehicle Penetration Loss	-10 dB
FS-RLAN Distance (horiz.)	2145 m
FS Gain (@1.11 degrees)	35.3 dB
Prop. Loss (WII LOS)	127.5 dB
TOTAL I/N	**-27.2 dB**

Additional Real-World Factors Reduce the Risk Even Further

Although outdoor operations are clearly critical, the overwhelming majority — 90%—of VLP use will be indoors. These will be subject to BEL in addition to the extremely low power limit and other factors.

Immersive VLP operations will take place in populated areas with 5G mmW or 6 GHz RLAN coverage. These locations will tend to be far away from FS links. (This is true in all three dimensions—where FS links are typically situated high above populated areas when they cannot go around them.)

And when there is an FS receiver in such an area, the evidence shows that these links are shorter, have greater fade margin,and at the same time less susceptibility to fade (due to the shorter length) than the average link.

4.5 dB body loss model is highly conservative based on our collective experience designing products.

In each of these cases I/N is easily below -6 dB. Moreover, as we have previously shown, even in an extreme hypothetical case where an FS receiver receives enough energy to theoretically cause harmful interference, the receiver will only be affected if this event coincides with a deep fade. But these fades generally occur only at night, when VLP devices are least likely to be in use.

VLP will not cause harmful interference to FS.